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Noah D. Hughes, Suzanne Paradis, James W. Sears and Michael Pope

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Lithology, tectonostratigraphy, and paleogeography of the Vavenby area, Eagle Bay Assemblage, south-central British Columbia, a possible constraint for the timing of the rifting of Laurentia[1]

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Abstract: New 1:20 000 scale mapping within the pericratonic rocks of the Eagle Bay Assemblage near Vavenby, south-central British Columbia, has revealed a stratigraphic transition from continental slope siliciclastic rocks of Latest Neoproterozoic or Early Cambrian age to a sequence dominated by thick successions of Early Cambrian mafic volcanic and volcaniclastic rocks with an associated archaeocyathid-bearing carbonate platform. These rocks are overturned and structurally emplaced above the Devonian and Mississippian portion of the Eagle Bay Assemblage. Overall, this section is interpreted as recording the transition from deeper water, turbiditic and pelagic sedimentation to a period of tectonism and creation of a shallow-water to subaerial, mafic volcanic edifice. These Latest (?)Neoproterozoic and Early Cambrian pericratonic rocks within the Eagle Bay Assemblage record a period of Early Cambrian tectonism and mafic volcanism, supporting recent models of continental separation in this region at that time.

Résumé : La nouvelle cartographie géologique à l'échelle de 1:20 000 des roches péricratoniques de l'Assemblage d'Eagle Bay près de Vavenby, dans le centre sud de la Colombie-Britannique, a révélé le passage stratigraphique des roches silicoclastiques (Néoprotérozoïque terminal ou Cambrien précoce) de talus continental à une séquence dominée par des successions épaisses de roches volcaniques mafiques et de roches volcanoclastiques (Cambrien précoce) associées à une plate-forme carbonatée à archéocyathidées. Ces roches sont renversées et mises en place structurellement au-dessus de la portion devonienne et mississippienne de l'Assemblage d'Eagle Bay. Dans l'ensemble, on interprète cette section comme témoignant du passage d'un milieu d'eau profonde à sédimentation turbiditique et pélagique à une période de tectonisme et de construction d'un édifice volcanique mafique dans un milieu d'eau peu profonde ou subaérien. Ces roches péricratoniques du (?)Néoprotérozoïque terminal et du Cambrien précoce de l'Assemblage d'Eagle Bay témoignent d'une période de tectonisme et de volcanisme mafique au Cambrien précoce, ce qui corrobore des modèles récents d'une ouverture du continent dans cette région à cette époque.

[1] Contribution to the Ancient Pacific Margin NATMAP Project

INTRODUCTION

The Vavenby map area straddles the North Thompson River near a prominent westerly bend in the river at the town of Vavenby, approximately 20 km east of Clearwater in south-central British Columbia (Fig. 1). It lies approximately between latitudes 51°31′ and 51°39′N and between longitudes 119°48′ and 119°38′W (NTS map sheets 82 M-052 and 82 M-062). Bedrock in the area consists of metasedimentary and metavolcanic rocks of the Eagle Bay Assemblage. The area is characterized by an Early Cambrian (and possibly older) succession tectonically emplaced (and overturned) over a Devonian–Mississippian succession (Schiarizza and Preto, 1987). Most of the rocks within the study area are highly deformed and have undergone lower greenschist facies metamorphism, except within contact aureoles of late granitic intrusions where higher metamorphic grades are present.

The main goal of this study is to place the rocks of the Vavenby area in the proper tectonostratigraphic and paleogeographic context using traditional mapping techniques, geochronology, and geochemical characterization.

Fieldwork in the Vavenby map area (Fig. 2) was conducted during an eight-week period in the summer of 2000 as the M.Sc. thesis project of the first author (Noah Hughes). This work was carried out in conjunction with the Geological Survey of Canada as part of the Ancient Pacific Margin NATMAP Project, a comprehensive analysis of the pericratonic terranes of the Canadian Cordillera. This paper presents preliminary results and interpretations of the work conducted thus far. Future work will focus on the geochemical characterization of mafic metavolcanic units, thin-section analysis of all units to better understand their nature and origin, and radiometric dating (U-Pb) of any zircon-bearing rocks.

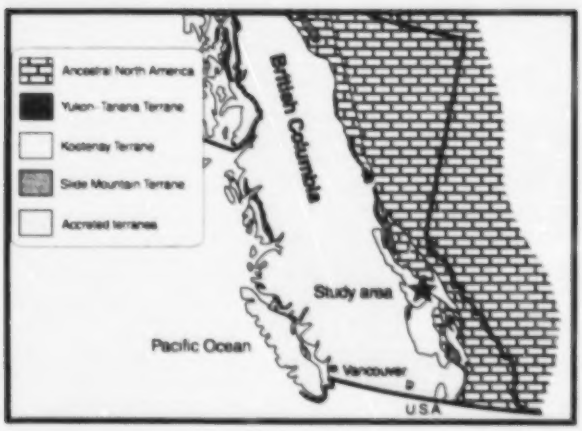

Figure 1. *Location of the Vavenby map area within the pericratonic Kootenay Terrane of southeastern British Columbia* (modified after *Wheeler and McFeely, 1991*).

The Vavenby map area is characterized by steep topography, dense vegetation, and thick deposits of glacial till and river gravels. Bedrock exposures can be found along logging roads (mostly inactive), clearcuts, mountain tops, cliffs, and creek canyons.

REGIONAL GEOLOGY

The term 'pericratonic' is used to describe Cordilleran rocks that lie between North American continental margin strata to the east and allochthonous oceanic terranes that have been tectonically emplaced to the west (Fig. 1). The pericratonic rocks are believed to have been deposited at the outermost edge of the North American continent during a period of dynamic tectonism that included processes related to the opening of the proto- Pacific domain as well as arc collision during the Jurassic (Thompson et al., 2000). Pericratonic terranes occur along the length of the Canadian Cordillera and into central Alaska. The metasedimentary and metavolcanic rocks of the Eagle Bay Assemblage are included in the pericratonic Kootenay Terrane of south-central and southeastern British Columbia (Wheeler and McFeely, 1991). The Eagle Bay Assemblage consists of a "...lower Paleozoic (and older?) succession of clastic metasediments, carbonate and mafic metavolcanic rocks, and an overlying Devonian–Mississippian succession of felsic to intermediate metavolcanic rocks and clastic metasediments..." (Schiarizza and Preto, 1987, p. 14). These rocks are locally intruded by Devonian orthogneiss and Cretaceous quartz monzonite and biotite granodiorite of the Baldy and Raft batholiths, respectively. The Early Cambrian (and possibly older) succession consists primarily of deformed and metamorphosed sandstone and arkosic grit that pass stratigraphically upward into a thick package of mafic metavolcanic rocks containing a fossiliferous, shallow-water carbonate unit (the Tshinakin Limestone). The Devonian–Mississippian package consists of felsic to intermediate metavolcanic rock, orthogneiss, metasedimentary rocks, and mafic metavolcanic rocks. The rocks of the Eagle Bay Assemblage occur in four tectonic slices separated by west- to southwest-verging thrust faults (Schiarizza and Preto, 1987). The Vavenby area contains rocks of the third and fourth of these faults slices. The third slice contains the Devonian–Mississippian succession, and the fourth slice contains the structurally overlying Early Cambrian (and possibly older) succession. These two packages are separated by the Vavenby Thrust Fault.

LOCAL STRATIGRAPHY

Unit 1

The oldest rocks recognized in the Vavenby area comprise a package of medium- to coarse-grained quartzose metasedimentary rocks. Despite regional deformation and metamorphism, these rocks (as well as those of unit 2, *see* below) often preserve original sedimentary textures. Unit 1 consists mainly of brown, grey-brown, bluish-grey, and greenish-grey quartzite and micaceous quartz arenite with

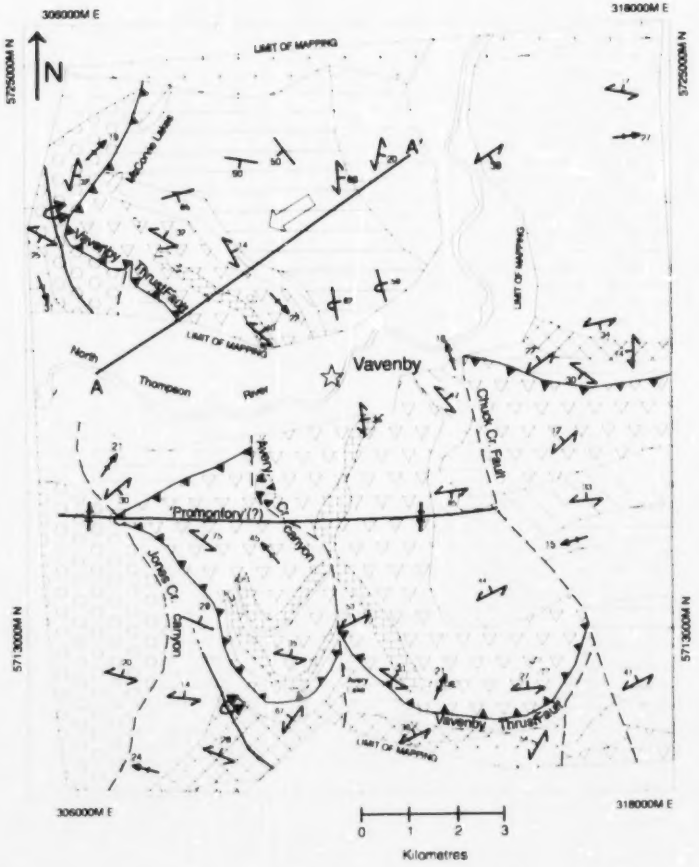

Figure 2. *Preliminary geological map of the Vavenby area (this study).*

Legend to Figure 2

- Unit 1: Metasedimentary rocks- quartzites; with lesser amounts of graphitic phyllite
- Unit 2: Metasedimentary rocks- coarse-grained arkosic grits
- Unit 3: Metavolcanic and carbonate rocks- feldspar-sericite (±quartz) schist; calcsilicate schist and marble
- Unit 4: Mafic metavolcanic rocks- calcareous greenstone
- Subunit 4a: Metasedimentary rocks- calcsilicate schist, quartzite, feldspar-sericite (±quartz) schist
- Subunit 4b: Tshinakin Limestone- limestone, dolomitic limestone, marble
- Unit 5: Metasedimentary rocks- phyllitic quartzite and conglomerate. Also silty limestone, sericite schist, and graphitic phyllite and/or slate
- Unit 6: Metavolcanic rocks- quartz-sericite (± chlorite) schist with minor graphitic phyllite and/or slate
- Unit 7: Metasedimentary rocks- graphitic phyllite and slate with lesser silty limestone, sericite (±chlorite) schist
- Unit 8: Orthogneiss, Devonian
- Unit 9: Granodiorite, Cretaceous

- Primary foliation, strike and dip
- Overturned bedding, strike and dip
- Upright bedding, strike and dip
- Syncline
- Overturned syncline
- Mesoscopic fold axis, trend and plunge
- Thrust fault, teeth on overlying plate
- Normal fault
- Younging direction
- Overturned anticline

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thin intervals of dark grey graphitic phyllite, slate, and calcareous and/or dolomitic sandstone (Fig. 2 and 3). These beds are tabular to slightly trough shaped and range from about 20 cm to 2 m in thickness. Grading with or without rip-up clasts is rare. The rip-up clasts are intraformational and derive from the graphitic slate. The sandstone is quartz-rich and composed of well sorted, fine to coarse sand-sized grains. Feldspar is a minor component of some beds. Unit 1 was mapped both above and below the Vavenby Thrust Fault.

In the footwall succession, it is reportedly in contact with unit 5 (referred to as units EBQ and EBA, respectively, Schiarizza and Preto, 1987). In the hanging wall succession, it is in contact with unit 2 (described below). The stratigraphic context of this unit remains unclear (*see* 'Discussion'). It is interpreted to represent deep-water turbiditic and pelagic sedimentation.

Unit 2

This sequence consists of green, green-grey, light grey, and grey-brown, coarse-grained, immature arkosic grit (Fig. 2 and 3). Bed geometries are dominantly tabular. Graded beds are common indicating an overall southwest-younging direction. These graded deposits often contain rip-up clasts. Hummocky cross-stratification and convoluted soft-sediment deformation are locally present at the tops of finer grained beds. Otherwise, the succession is massive.

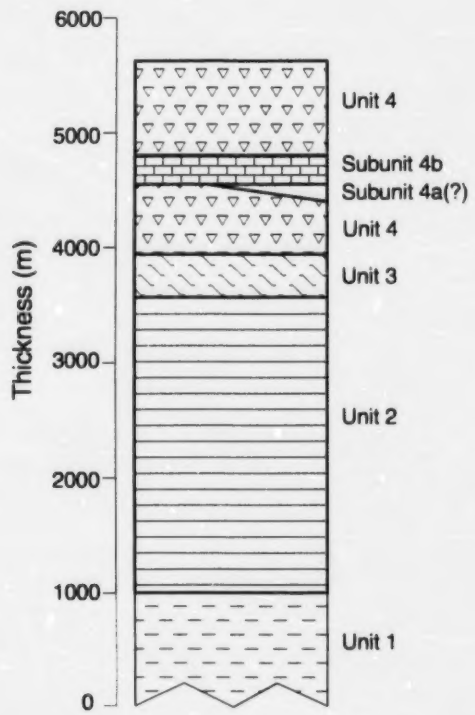

Figure 3. *Schematic stratigraphic section of the early Cambrian (and possible older) succession of the Eagle Bay Assemblage northwest of Vavenby.*

Grain size generally ranges from medium sand to granule, although small cobbles (up to 35 mm) were seen near the top of this unit. Fine-grained chlorite, chlorite with graphite, and/or chlorite with sericite are common in the matrix of these rocks and become more abundant toward the top of the unit, giving it a distinct green colour. This matrix locally makes up to 25% of the rock. Feldspar generally represents about 30% of the rock and locally as much as 50%. The feldspars are subrounded to subangular; minor (?)ankerite alteration is common. They generally exhibit the same size range as the quartz grains. The quartz grains are smoky and, less commonly, blue. This unit is interpreted as a shoaling-upward sedimentary sequence dominated by turbidite units consisting of immature clastic sediments derived from a nearby basement source. The presence of hummocky cross-stratification near the top of the unit suggests a nearshore environment of deposition. Intercalations of chlorite-sericite phyllite and feldspar-sericite schist form part of a mixed gradation into unit 3.

Unit 3

This unit is composed of grey, white, and/or orangish-grey feldspar-sericite schist, feldspar-quartz-sericite schist, and quartz-feldspar-chlorite-sericite schist. Greyish calcsilicate schist, marble, and chlorite-laminated marble are present and make up most of this unit in the northern part of the map area (Fig. 2). Fine-grained chlorite-phyllite and chloritoid porphyry are also common. The feldspar-sericite schist is fine to medium grained. Locally, the schist may contain up to 10% hornblende. Lapilli-sized fragments were seen at several localities. Small ankerite and/or siderite grains are common, commonly giving an orange speckled appearance to the schist. Small (1 mm), rounded quartz eyes were observed at several localities. The carbonate-bearing part of this unit appears to overlie the feldspar-sericite schist, and intercalations of these two rock types were seen at several localities. North of the North Thompson River, the carbonate facies comprises at least 80% of the exposures whereas south of the river, it is less dominant. The contact is gradational, consisting of a mixture of each. The upper (carbonate-bearing) contact with unit 4 is also gradational. The chlorite-rich rocks within this unit are often coarse grained and porphyritic with abundant miarolitic cavities; they may represent shallow-level intrusive feeder dykes for the overlying mafic metavolcanic rocks (unit 4). Overall, this unit is likely to have been derived from felsic to intermediate metavolcanic rocks deposited in a carbonate-rich environment.

Unit 4

This succession is dominated by chlorite-rich, calcareous greenstone and greenschist (Fig. 2 and 3). Plagioclase-phyric rocks are common. Textures are massive, fragmental, tuffaceous, porphyritic, vesicular and amygdaloidal, and trachytic. This volcanic sequence also contains a thick carbonate horizon (unit 4b). Fragmental greenstone is common and forms sequences tens to hundreds of metres thick. These rocks generally are matrix supported (10–60%); grain-supported fragmental greenstone is rare. Fragments

range from lapilli- to bomb-sized (several metres in diameter) and their composition is usually similar to that of the matrix. The fragments are well rounded and/or slightly flattened. Small marble pods and lenses as well as rare dropstones are present in fine-grained mafic metatuff intervals near the structural base of the unit; its contact with unit 3 was not observed. Unit 4 represents a period of mafic volcanism (and possible intrusion) and tectonism.

Subunit 4a

This is a relatively thin subunit that occurs in a few small outcrops in the southwest corner of the map area (Fig. 2). It is comprised of grey to purplish-grey, fine-grained calcsilicate schist and quartzite, as well as grey, fine-grained siliceous feldspar-sericite schist and micaceous quartz-feldspar-sericite schist. (?)Ankerite is common, probably altered from feldspar. These rocks are poorly exposed, but appear to occur between unit 4 and unit 4b in an overturned fault panel. They likely represent a period of increased clastic sedimentation and (?)volcanism associated with deposition of the carbonates of subunit 4b.

Subunit 4b (Tshinakin Limestone)

This unit is composed of light to medium grey limestone, dolomitic limestone, and/or marble (Fig. 2 and 3). It occurs as a single, thick package hundreds of metres thick, as two distinct packages separated by a relatively thin sequence of mafic volcanic and/or metasedimentary rocks of units 4 and 4a, or as a preponderance of large carbonate megaclasts within the mafic volcanic rocks of unit 4. It seems to vary in thickness and, in some areas, to rapidly pinch out into a series of large carbonate blocks from one to tens of metres across. Where this unit is thick, it forms prominent cliffs and is a useful marker bed in an area of relatively few outcrops. It is commonly recrystallized and massive, with flaggy partings locally. It often contains fine chloritic laminae and mottling where it is interbedded with unit 4. Locally, the Tshinakin Limestone contains oolitic packstone and Early Cambrian archaeocyathids. Intraformational breccia, grey and white banding, stylolites, and vague linear ((?)bedding) features were observed locally. The Tshinakin Limestone is interbedded with the greenstone of unit 3, indicating a stratigraphically concordant relationship. It is interpreted to be a shallow-water carbonate platform.

Unit 5

This is a heterogeneous unit consisting of phyllitic sandstone and phyllitic quartz conglomerate, with lesser amounts of dark grey, silty limestone and graphitic and sericitic phyllite and/or slate (Fig. 2 and 3). No conclusive bedforms were seen in this unit. Phyllitic sandstone and conglomerate contain fine lamina of chlorite, chlorite-sericite, and chlorite-graphite phyllite. The sandstone is generally a well sorted, fine-grained quartz arenite. The conglomerate contains about 30% to 60% granular to pebble-sized quartz clasts, which are either (in order of decreasing abundance) blue, milky, or smoky. In this conglomerate, the phyllitic matrix makes up 10% to 90% of the rock. The limestone is uniformly dark grey to black with a well developed slaty cleavage that shows carbonaceous silt upon parting.

Unit 6

This unit is composed mainly of grey, silvery grey, and silvery greenish-grey quartz-, sericite schist and quartz-sericite-chlorite schist. Lesser amounts of graphitic phyllite and/or slate are present locally. A thin interbed of quartz-granule conglomerate was seen at one locality. These rocks outcrop in the southern part of the map area and seem to thin rapidly to the east until they are truncated by the Vavenby Thrust Fault (Fig. 2). In this area they are also locally underlain, and intruded by, a Devonian orthogneiss. North of the North Thompson River, rock types of unit 6 represent a minor part of the stratigraphic transition from unit 5 to unit 7 and cannot be mapped separately. Unit 6 is likely derived from felsic to intermediate volcanic tuffs (Schiarizza and Preto, 1987).

South of the Vavenby map area, unit 6 rocks have yielded middle Devonian zircon ages where they outcrop near Adams Lake (Schiarizza and Preto, 1987).

Unit 7

This unit is dominated by dark grey graphitic phyllite and slate. Locally, it contains lesser amounts of thin-bedded, dark grey, silty limestone, silvery grey sericite phyllite, and greenish-grey chlorite-sericite phyllite. It is commonly silicified in association with silica veinlets near where it is truncated by the Vavenby Thrust Fault. Mississippian conodonts occur in correlative units within the Eagle Bay Assemblage (Schiarizza and Preto, 1987). Contacts with unit 6 are gradational and interpreted as stratigraphically concordant.

STRUCTURE AND METAMORPHISM

The oldest recognized structure in the area is a premetamorphic fault exposed on the west side of Jones Creek canyon, in the southwestern part of the map area (Fig. 2). This fault is north-trending, moderately east-dipping, and separates different sedimentary rock types near the contact between units 5 and 7. It has been speculated that such premetamorphic faults may be syndepositional and define abrupt changes in lithological units within the Devonian–Mississippian package (Schiarriza and Preto, 1987; K.L. Daughtry, pers. comm., 2000). Some of these faults may have been recently reactivated as Eocene north-trending normal faults. However, Bailey et al. (2000) interpreted a premetamorphic thrust fault in a similar stratigraphic and structural setting to the south, near Johnson Lake, possibly providing an alternative explanation for this premetamorphic fault.

The area is dominated by a penetrative, synmetamorphic cleavage that is axial-planar to a series of north- to northwest-trending, southwest-verging, overturned mesoscale and macroscale folds. These features are likely related to movement on the south- to southwest-verging Vavenby Thrust Fault (Fig. 4). The hanging-wall succession of this fault is interpreted to make up the west limb of one of these large-scale folds. In the northwestern part of the map area, the fold limb is upright and beds dip steeply to the southwest. Southeastward along strike, bedding planes steepen and eventually become overturned. To the east and southeast of this map area, the same rocks are overturned in gently dipping beds of the west-trending 'Graffunder Lakes Synform' (Schiarizza and Preto, 1987). Therefore, these rocks make up the west limb of a large northwest-trending fold-nappe structure that becomes overturned along its axial trace to the southeast. The region of preserved sedimentary textures within units 1 and 2 is likely associated with the relatively undeformed 'nose' of this structure. Within the Devonian–Mississippian succession, these folds are evident in map pattern geometries and inferred by stratigraphic relationships. North- to northwest-trending folds, the synmetamorphic cleavage, and the Vavenby Thrust Fault are likely penecontemporaneous. However, latest movement on the Vavenby Thrust Fault seems to have postdated the synmetamorphic cleavage as it is slightly offset along the fault. This generation of deformation is probably Jura–Cretaceous and related to the Columbian Orogeny (Schiarizza and Preto, 1987).

A later episode of deformation is represented by broad west-trending folds. This deformational episode is likely related to the emplacement of the Baldy Batholith and/or the west-trending Raft Batholith. These intrusive bodies are middle Jurassic to Cretaceous (Schiarizza and Preto, 1987; Logan, 2000), which is likely the age for this deformational episode. An example of this fold generation is a synformal structure on the south side of the North Thompson River, indicated by large-scale folding of the primary foliation. This synform may preserve a west-trending 'promontory' of the structurally overlying rocks in the hanging wall of the Vavenby Thrust fault (Fig. 2). As such, it could be a western expression of the Graffunder Lakes Synform first recognized by Schiarizza and Preto (1987). Other stratigraphic relationships in the area suggest that axial-parallel antiformal structures may also be present. For instance, the Vavenby Thrust Fault appears to be a generally shallowly dipping feature in this area, and localized tectonic 'windows' in the Avery Creek canyon may be controlled in part by west-trending antiforms. Structural control for these folds is poor, however, and map-pattern geometries such as the west-trending promontory, described above, could be explained in other ways. To the south, near Johnson Lake, Bailey et al. (2000) reported mafic metavolcanic rocks that may lie within the Devonian succession just below the Haggard Creek Thrust Fault (which is part of the same thrust system as the Vavenby Thrust Fault). Apparently, these metavolcanic rocks are chemically distinct from the Cambrian metavolcanic package. Geochemical analysis will help determine whether the mafic metavolcanic rocks of the promontory are actually part of the Early Cambrian succession.

Another period of tectonism is represented by a series of north-trending west- and east-side-down normal faults interpreted to be of Eocene age. One east-side-down fault, the Chuck Creek Fault, is seen in a new roadcut along the Vavenby-Adams road about 1 km east of Chuck Creek. One of these faults is known to be of Eocene age, and this is likely the age of this episode of deformation (Schiarizza, 1982). Perhaps the youngest structure in the area is a west- to northwest-trending fault that defines the North Thompson River valley between Vavenby and Clearwater. This structure appears to be a south-side-down normal fault that truncates the northerly trending faults in the area.

Locally, the primary foliation is crenulated and commonly shows a well developed crenulation cleavage. This crenulation cleavage seemed to occupy various orientations and more study is needed to verify its age. Other workers have assigned an Eocene age to crenulation cleavage and late kinks in the area (Schiarizza and Preto, 1987). The undeformed nature of the crenulation cleavage in the Vavenby area agrees with the interpretation that these structures are part of the youngest deformational episode in this region.

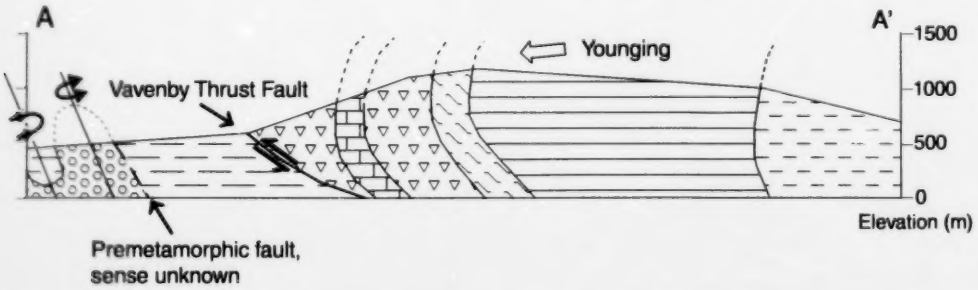

Figure 4. *Southwest to northeast cross-section through the Eagle Bay Assemblage northwest of Vavenby, British Columbia. See line A-A' on Figure 2. No vertical exaggeration. Note that the part below the Vavenby Thrust Fault is not seen in outcrop and is extrapolated from the mapped area.*

MINERALIZATION

South of the Vavenby map area, outcrops of correlative rock units host base-metal sulphide mineralization of syngenetic and epigenetic origins (Höy and Goutier, 1986; Bailey et al., 2000). This makes it reasonable to speculate that rocks of the Vavenby area may also host significant mineralization. Indeed, several showings of sulphide mineralization have been reported in and around the Vavenby map area. These showings can be classified as one of two general types, i.e. large-tonnage, low-grade Cu-Pb-Zn (Harper Creek, Sin, VM, VAV North, and VAV South), or small, quartz-vein-hosted Ag-Au-Pb deposits (Tinkirk, Big Chief, and Morrison).

The large-tonnage, low-grade Cu-Pb-Zn deposits occur in unit 6 (units EBA and EBAgn of Schiarizza and Preto, 1987). The Harper Creek and VAV South deposits also contain significant molybdenum. Only the Harper Creek deposit has seen significant development. Various parts of the deposit were staked by Noranda Exploration Company Limited and Quebec Cartier Mining Company in 1966. Exploration work continued into the early 1970s, and the deposit was studied in detail by Belik (1973) and Höy (1997). More recently, American Comstock Exploration Ltd. acquired 100% interest in the deposit, and renewed exploration efforts resulted in a 171 m section of core grading 0.31% copper (www.em.gov.bc.ca/mining/Geol/surv/minfile, September 27, 2000).

Overall, the reserves of this prospect are estimated at 96 million tonnes grading 0.41% copper, 0.045 g/t gold, and 2.5 g/t silver (www.em.gov.bc.ca/mining/Geol/surv/minfile; September 27, 2000). However, one area (the 'East zone') contains reserves of 53 million tonnes grading at 0.37% copper, 0.016% molybdenum, 2.8 g/t gold, and 88.4 g/t silver that could be extracted by open-pit mining. This deposit contains lesser amounts of titanium, zinc, and lead. Mineralization is hosted in tabular, chalcopyrite-rich zones.

Harper Creek has been interpreted as a volcanogenic sulphide deposit within deformed and metamorphosed Late Devonian metavolcanic rocks (unit EBA of Schiarizza and Preto, 1987) of the Eagle Bay Assemblage (Höy, 1997). The succession that hosts the deposit comprises two sequences of felsic to intermediate tuffs, separated by mafic tuffs and interbedded fine-grained clastic sedimentary units. Mineralization includes large zones of disseminated sulphides (pyrite, pyrrhotite, chalcopyrite) essentially parallel to foliation trends, and several thin, massive to semimassive sulphide and sulphide-magnetite layers (Belik, 1973; Höy, 1997).

All the above showings occur within the Devonian–Mississippian package below or near the Vavenby Thrust Fault. During the course of this study, quartz-vein-hosted pyrite and chalcopyrite showings in similar stratigraphic and structural positions were observed throughout the area; these were particularly prevalent near the headwaters of Jones Creek and near the Vavenby Thrust Fault where the veins occur both parallel to the penetrative foliation and folded by synmetamorphic folds.

Above the Vavenby Thrust Fault, the Early Cambrian (and possibly older) succession has been less well explored. However, the same succession has produced sediment-hosted Pb-Zn-Ag deposits to the south on the Adams Plateau (Elsie, Lucky Coon, King Tut, Spar, Pet, and Mosquito King claims). In the Vavenby map area, a package of similar metasedimentary rocks (unit 4a) occurs at the same stratigraphic level. It is poorly exposed in roadcuts of a new extension of the Saskum Plateau Road, in the southwestern part of the map area. Only sparsely disseminated pyrite was seen. Possible sulphides within volcanogenic-exhalative textures were noted at several localities within unit 4. These rocks commonly contained significant disseminated magnetite. Massive magnetite was also seen in late tension gashes (approximately 1 cm by 3 cm).

DISCUSSION

The map area is dominated by a locally overturned, Early Cambrian (and possible older) succession of quartz-rich and arkosic metasedimentary rocks and greenstone, structurally emplaced above Devonian to Mississippian metasedimentary and metavolcanic rocks. The older succession is of particular interest because the age of these rocks corresponds to an established period of rifting (Bond and Kominz, 1984; Devlin and Bond, 1988; Lickorish and Simony, 1995; Warren, 1996). The stratigraphic succession that includes units 2 through 4 consists of coarse-grained, immature sedimentary rocks (unit 2) that pass stratigraphically upward into thick sequences of mafic metavolcanic rocks (unit 4) (Fig. 2 and 3). These units are separated by a relatively thin strata of intermediate metavolcanic rocks (unit 3) that may represent an initial stage of felsic to intermediate volcanism. Subunit 4b, the Tshinakin Limestone, is contained within the mafic volcanic rocks of unit 4. Overall, this succession is interpreted as recording the transition from deeper water, turbiditic and pelagic sedimentation to a period of tectonism and creation of a shallow-water to subaerial, mafic volcanic edifice. This volcanic edifice supported an Early Cambrian carbonate platform that was subsequently overwhelmed by mafic volcanic and/or volcaniclastic deposits.

The relationship of unit 1 to the above succession is as yet unclear. In the northwest corner of the map area, it appears to be stratigraphically overlain by unit 2, which is Early Cambrian or older. Beneath the Vavenby Thrust Fault, it is in contact with unit 6, which is middle Devonian. An ongoing part of this study is to determine the nature of these various tectonostratigraphic relationships. At present, the contact between unit 2 and unit 1 is considered to be concordant, whereas the contact with unit 6 is thought to be unconformable. Another goal of this study is to correlate these units with other components of the Kootenay Arc. The main link is the archaeocyathid-bearing Tshinakin Limestone, which provides a time-stratigraphic correlation with the large archaeocyathid-bearing carbonate platform (Badshot-Donald-Mural Formation) preserved farther east in the Kootenay Terrane. Schiarizza and Preto (1987) reported an archaeocyathid locality within the Tshinakin Limestone,

northwest of Vavenby. The present study confirms the presence of Early Cambrian archaeocyathids near that locality (Mike Pope, pers. comm., 2000) and possibly at one other location near Avery Lake, in the southern part of the map area (Fig. 2) (identification still pending). Preliminary results suggest correlation of units 2 and 4 with the 'greenstone and graded sandstone' of the Hamill Group (which underlies the Badshot-Donald-Mural carbonate platform farther west) as seen in the northern Selkirk Mountains (Devlin, 1989). Unit 1 may be correlative with the 'lower' sandstone unit of the Hamill Group in this region. Various regional unconformities within the Hamill and Gog groups have been proposed as expressions of the 'rift-to-drift' transition (Kubli and Simony, 1992; Warren, 1997). The lithological units present in this succession, as well as the rocks they correlate to, support the interpretation that units (?)1, 2, 3, and 4 record a period of tectonism and volcanism associated with the breakup of North America by the latest Early Cambrian.

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